

### REMARKS

The Office Action of April 7, 2009 has been reviewed and the Examiner's comments carefully considered. New claims 8 and 9 have been presented by way of this Amendment. Accordingly, claims 1, 3, 4 and 7-9 are currently pending in this application with claims 1 and 3 being in independent form. Support for the amendments can be found on page 8, lines 22-23 of the specification. Applicants respectfully submit that no new matter has been added by way of this Amendment.

The Notice of References Cited (Form PTO-892) accompanying the outstanding Office Action does not list U.S. Patent No. 6,367,133 to Ikada et al., which is cited in the Office Action in the rejection under 35 U.S.C. §103(a). Applicants respectfully request that U.S. Patent No. 6,367,133 be listed in a Notice of References Cited (Form PTO-892) accompanying the Office Action responding to this Amendment to ensure this reference appears in the list of References Cited for any patent issuing from the current application.

Claims 1 and 3 stand rejected under 35 U.S.C. §103(a) for obviousness over U.S. Patent Application Publication No. 2002/0022292 to Barber et. al. (hereinafter "Barber") in view of U.S. Patent No. 6,367,133 to Ikada et al. (hereinafter "Ikada"), U.S. Patent No. 5,646,657 to Aoki (hereinafter "Aoki"), LI ET AL. *High Sensitive . . . Melting Photoresist*, The 12<sup>th</sup> Int'l Conf. on Solid States Sensors, Actuators and Microsystems, IEEE 6/8/03 (hereinafter "Li") and U.S. Patent Application Publication No. 2004/0016718 to Hwu et al. (hereinafter "Hwu"). Claim 4 stands rejected under 35 U.S.C. §103(a) for obviousness over Barber in view of Ikada, Aoki, Li and Hwu, and in further view of U.S. Patent No. 4,487,828 to Hladovcak et al. (hereinafter "Hladovcak"). Claim 7 stands rejected under 35 U.S.C. §103(a) for obviousness over Barber in view of Ikada, Aoki, Li and Hwu, and in further view of U.S. Patent No. 6,530,652 to Kim et al. (hereinafter "Kim"). These rejections are respectfully traversed.

Independent claim 1 defines a method of manufacturing a piezoelectric element, including the steps of: applying a masking agent to a surface of a piezoelectric material to form a

film of the masking agent on the surface of the piezoelectric material; patterning the film of the masking agent into a predetermined masking pattern; selectively applying an oil repellent to surface portions of the substrate which are not covered with the patterned film; holding the patterned film in contact with a vapor of a solvent for the masking agent, diluted with an inert gas, so as to fluidize the film to a domed shape on the surface of the piezoelectric material, wherein the vapor diluted with the inert gas is formed by bubbling the solvent with the inert gas; curing the dome-shaped film; and dry etching the piezoelectric material together with the cured film, so as to process the piezoelectric material into a three-dimensional convex profile corresponding to thickness distribution of the domed shape.

Independent claim 3 defines a method of manufacturing a piezoelectric element, including the steps of: applying a masking agent to a surface of a substrate made of a piezoelectric material to form a film of the masking agent on the surface of the substrate; patterning the film of the masking agent into a predetermined masking pattern; selectively applying an oil repellent to surface portions of the substrate which are not covered with the patterned film; contacting the patterned film with a vapor of a solvent for the masking agent, diluted with an inert gas, to fluidize the patterned film into a dome shape, wherein the vapor diluted with the inert gas is formed by bubbling the solvent with the inert gas; curing the dome-shaped film; and dry etching the surface of the substrate together with the cured film to process the substrate into a three-dimensional convex structure of a profile corresponding to a thickness distribution of the domed shape.

Applicants respectfully submit that in order to establish a *prima facie* case of obviousness, three criteria must be met. First, the modification or combination must have some reasonable expectation of success. Second, the prior reference or combined references must teach or suggest all the claim limitations. MPEP §2143. Finally, an apparent reason for one of ordinary skill in the art to combine the prior art teachings to reach the claimed invention should be identified. *KSR Int'l Co. v. Teleflex, Inc.*, 82 USPQ2d 1385 (U.S. 2007). The analysis of an obviousness finding should be made explicit. *Id.*

Applicants submit that the teachings of Barber, Ikada, Aoki, Li, Hwu, Hladovcak and Kim, taken separately or combined, fail to teach or suggest all of the claimed limitations of amended claims 1 and 3.

Barber teaches a method for shaping thin film resonators (20) comprising a piezoelectric substrate (21). A photo resist (22) is first applied to a surface of the substrate (21) and then shaped into a pattern of resist cylinders (23) on the substrate (21). The photo resist cylinders (23) are then melted into dome shaped drops (24) by one of several possible techniques, including by exposing the resist cylinders (23) to the vapors of a suitable resist solvent in an evacuated heated chamber. Reactive Ion Etching (RIE) or another suitable technique is then used to transfer the resist lenses into the substrate (21) to form a partial resist (25). Upon completion of the RIE process, the final structure (26) of the resonator (20) includes the desired contour. Please note Fig. 3 and paragraphs [0028]-[0030] appearing on page 3 of Barber.

According to the Office Action, Barber inherently teaches that the solvent vapor is diluted with an inert gas because gas pockets or bubbles inherently occur when mixing a vapor with a gas. Applicants respectfully disagree. Barber expressly teaches at paragraph [0030] that the photo resist cylinders (23) are exposed to the vapors of the solvent in an evacuated heated chamber. Thus, Barber teaches that the vapors of the solvent are not diluted by or mixed with any gas. At no point does Barber teach or suggest contacting a patterned film of masking agent with a vapor of a solvent for the masking agent, diluted with an inert gas, to fluidize the patterned film into a dome shape or that the vapor diluted with the inert gas is formed by bubbling the solvent with the inert gas, as is claimed. Further, as acknowledged by the Office Action, Barber also fails to teach or suggest selectively applying an oil repellent to surface portions of the substrate which are not covered with the patterned film of the masking agent.

Ikada teaches a process of manufacturing a surface acoustic wave apparatus wherein separate conductor films (4, 7) made from a conductive material, such as aluminum, are

applied across an entire surface of a piezoelectric substrate (3) and then across a layer of photo-resist (5, 6) applied to the piezoelectric substrate. Please note Figs. 1A-1F and column 7, line 1 to column 8, line 11 of Ikada.

According to the Office Action, Ikada teaches the step of selectively applying an oil repellent to surface portions of the piezoelectric substrate which are not covered in patterned film. Applicants respectfully disagree. As discussed above, Ikada teaches applying a conductive film (4) entirely across the piezoelectric substrate (3) as is shown in Fig. 1A. Later, another layer of conductive film (7) is applied to layers of patterned and un-patterned resist (5, 6). At no point does Ikada teach or suggest the step of selectively applying an oil repellent to surface portions of a substrate which are not covered with the patterned film, as is claimed in claims 1 and 3. Ikada also fails to teach or suggest contacting a patterned film of masking agent with a vapor of a solvent for the masking agent, diluted with an inert gas, to fluidize the patterned film into a dome shape, that the vapor diluted with the inert gas is formed by bubbling the solvent with the inert gas, as is claimed in claims 1 and 3.

Moreover, Ikada applies the conductive films (4, 7) to form electrodes on the piezoelectric substrate (3) and not to form domed piezoelectric elements. One of ordinary skill in the art would see no benefit or motivation to applying conductive layers as taught by Ikada to piezoelectric substrates in the process taught by Barber as neither Ikada, nor any other art of record, addresses the benefits achieved by doing so in the process of Barber. Ikada, therefore, fails to fairly suggest a modification to the process taught by Barber, in combination with the teachings of the other applied references, which achieves the claimed invention.

Aoki teaches the application of a water and oil repellent film (21) on the surface of a nozzle sheet (10) made of polyimide to form a nozzle plate (9) for an ink jet printer head for the prevention of variations of the ejected ink. Nozzles (11) are formed in the sheet (10) and layer of repellent film (21) by an excimer laser. To that end, the repellent film (21) also includes an ultraviolet absorbing agent to increase dimensional accuracy in the processing of the repellent

film (21) by the excimer laser. Please note Figs. 2 and 3 and column 3, line 30 to column 4, line 34 of Aoki.

Applicants respectfully submit that “[t]he Examiner must determine what is ‘analogous prior art’ for the purpose of analyzing the obviousness of the subject matter at issue.” A prior art reference must either be in the Applicant’s field of endeavor or be reasonably pertinent to “a need or problem known in the field of endeavor at the time of the invention and addressed by the patent [or application at issue].” MPEP §2141.01(a)(I).

Applicants submit that Aoki is non-analogous prior art and cannot be relied upon as a basis for rejecting Applicants’ claims. The claimed invention relates to the manufacture of piezoelectric elements having three-dimensional convex profiles formed thereon. An oil-repelling film is applied to a surface of the substrate to repel solvents of the masking agent from the surface of the substrate so as to reduce a surface tension of the substrate at the surface part where formation of piezoelectric elements is not intended. Please note Fig. 1(b) and page 5, lines 17-27 of the specification. Aoki does not relate to the manufacture of piezoelectric devices or to repelling etchants from a substrate surface during an etching process. Further, the oil repellent film taught by Aoki is provided on a nozzle sheet for an ink jet printer head to improve the ejection characteristics of the nozzle. The present invention does not address the prevention of variations of ejected ink from nozzle plates in an ink jet printer head.

Moreover, Aoki does not teach or suggest contacting a patterned film of masking agent with a vapor of a solvent for the masking agent, diluted with an inert gas, to fluidize the patterned film into a dome shape, that the vapor diluted with the inert gas is formed by bubbling the solvent with the inert gas, or selectively applying an oil repellent to surface portions of the substrate which are not covered with the patterned film of the masking agent, as is claimed. Rather, Aoki teaches applying the oil repellent (21) across the entire surface of the nozzle plate (9). Aoki, therefore, does not fairly suggest a modification to the process taught by Barber, in

combination with the teaching of the other applied references, which achieves the claimed invention.

Li teaches a process of forming a miniaturized plano-convex quartz crystal microbalance (QCM) by applying a layer of patterned photoresist to a substrate of AT-cut quartz crystal, melting the photoresist by heating at 200 °C, curing the melted photoresist, then performing reactive ion etching (RIE) on the cured pattern by using a mixture gas of SF<sub>6</sub> and Xe. Please note pages 508-509 of Li.

According to the Office Action, Li teaches a vapor solvent with an inert gas to melt a resist. Applicants respectfully disagree. As discussed above, Li teaches that the photoresist is melted into a domed shape by heating the photoresist and substrate at 200°C. The mixture of SF<sub>6</sub>, a powerful acid etchant, and Xe is utilized subsequent to the step of melting the photoresist into a domed shape in order to perform reactive ion etching on the cured resist pattern, which, as is discussed in the present application and in Barber at paragraphs [0028]-[0030] appearing on page 3, is a separate step from the step of melting the resist. At no point does Li teach or suggest contacting a patterned film of masking agent with a vapor of a solvent for the masking agent, diluted with an inert gas, to fluidize the patterned film into a dome shape or that the vapor diluted with the inert gas is formed by bubbling the solvent with the inert gas, as is claimed in claims 1 and 3. Li also fails to teach or suggest the step of selectively applying an oil repellent to surface portions of a substrate which are not covered with the patterned film, as is claimed in claims 1 and 3. Li, therefore, fails to fairly suggest a modification to the process taught by Barber, in combination with the teachings of the other applied references, which achieves the claimed invention.

With regard to Hwu, this reference teaches a process for making micro-optic elements having a plurality of photo resist elements (105) formed on a substrate (101), which are then melted by heat (115) to form domed photo resist elements (117), which are subsequently etched by an etch gas (125) to form a number of lenses (127). Please note Figs. 1 and 2 and

paragraphs [0020]-[0029] appearing on pages 2-3 of Hwu. Hwu does not teach or suggest contacting a patterned film of masking agent with a vapor of a solvent for the masking agent, diluted with an inert gas, to fluidize the patterned film into a dome shape, that the vapor diluted with the inert gas is formed by bubbling the solvent with the inert gas, or selectively applying an oil repellent to surface portions of the substrate which are not covered with the patterned film of the masking agent, as is claimed in claims 1 and 3. Hwu, therefore, does not fairly suggest a modification to the process taught by Barber, in combination with the teachings of the other applied references, which achieves the claimed invention.

With regard to Hladovcak, this reference teaches curing laminates of dry film of photo-sensitive polymer material applied to surfaces (13,14) of a substrate (11) of a printed wiring board (10) with ultra-violet light. Please note Figs. 1 and 3 and column 3, line 8 to column 4, line 12 of Hladovcak. Hladovcak does not teach or suggest contacting a patterned film of masking agent with a vapor of a solvent for the masking agent, diluted with an inert gas, to fluidize the patterned film into a dome shape, that the vapor diluted with the inert gas is formed by bubbling the solvent with the inert gas, or selectively applying an oil repellent to surface portions of the substrate which are not covered with the patterned film of the masking agent, as is claimed. Hladovcak, therefore, does not fairly suggest a modification to the process taught by Barber, in combination with the teachings of the other applied references, which achieves the claimed invention.

With regard to Kim, this reference teaches the dry etching of a piezoelectric element with chlorine gas. Please note column 7, line 17-22. Kim does not teach or suggest contacting a patterned film of masking agent with a vapor of a solvent for the masking agent, diluted with an inert gas, to fluidize the patterned film into a dome shape, that the vapor diluted with the inert gas is formed by bubbling the solvent with the inert gas, or selectively applying an oil repellent to surface portions of the substrate which are not covered with the patterned film of the masking agent, as is claimed. Kim, therefore, does not fairly suggest a modification to the

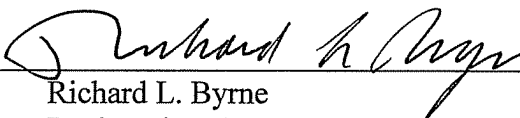
process taught by Barber, in combination with the teachings of the other applied references, which achieves the claimed invention.

Applicants submit that independent claims 1 and 3 are allowable for at least the foregoing reasons, as the teachings of the prior art of record, including Ikada, Aoki, Li, Hladovcak and Kim, are not sufficient to overcome the deficiencies in the teachings of Barber with respect to claims 1 and 3. Applicants respectfully request that the rejections of these claims be withdrawn.

Claim 8 is dependent upon and adds further limitations to independent claim 1. Claims 4, 7 and 9 are dependent upon and add further limitations to independent claim 3. These claims are allowable for at least the same reasons discussed above in connection with claims 1 and 3. Applicants respectfully request that the rejections of these claims be withdrawn.

In view of the above amendments and remarks, reconsideration of the rejections and allowance of claims 1, 3, 4 and 7-9 are respectfully requested.

Respectfully submitted,  
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